Space Weather Technical Forecast

Issued on Wednesday, 21 September 2022 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares (R1-R2 Radio Blackout). G1/Minor or G2/Moderate Geomagnetic Storm intervals likely late day 2 (22nd) or day 3 (23rd). Active Electron Fluence following later day 4 (24th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate over the past 24 hours, with an M1.1 flare from AR3102 at 20/1122 UTC, and a number of C-flares also observed. There are six sunspot regions on the solar disc, four of which are numbered. AR3102 Esi/Beta has been the most active, but has seen some decline of its intermediate spots and remains in a relatively simple magnetic configuration. AR3105 Dki/Beta is the largest group on the disc, however this is also in a stable and simple bipolar configuration, with its east to west orientation limiting the extent of any shear across its magnetic field lines. The other region of interest is a new region close to the southwest limb that has yet to be numbered. This is currently too close to the limb for an accurate analysis, however this appears to be in a less stable configuration, although is smaller than AR3105. No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind , as measured by DSCOVR and ACE at L1, has generally persisted at slightly elevated levels, with speeds varying between 450-520km/s, perhaps due to ongoing influence of the fast wind of CH23/-. Density was mostly at average levels. The total interplanetary magnetic field (IMF), Bt has been largely Weak, between 4-6nT. The north-south component Bz, fluctuated between -5 nT and +5 nT. The phi angle remained negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, eased to be close to background levels. High energy electron flux (greater than 2 MeV) was at background to Moderate, with peak value 409 pfu at 20/2110 UTC. The associated 24 hour fluence remained well below the Active (1e8 integrated pfu) threshold. Observed fluence at 20/0000 UTC was 7.31e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate with further C-flares and a chance of M-flares. The main M-flare risk is from AR3102 or AR3105, although the new region following AR3106 will need monitoring as it rotates onto the disc.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Slightly elevated solar winds are expected to gradually ease towards background, with the next enhancement, from the fast wind of CH25/+ expected either late day 2 (22nd) or day 3 (23rd). Geomagnetic activity is expected to be generally Quiet with isolated Unsettled spells until later day 2. There is the potential for activity to increase to Active to G1/Minor Storms, with a chance for G2/Moderate Storm intervals either late on day 2, or day 3 (22nd or 23rd). Conditions then easing to Quiet to Unsettled, with isolated Active spells through day 4 (24th).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES-16, is expected to continue to fall to background levels. The high energy electron flux (greater than 2 MeV) is expected to persist at Background to Moderate, before rising in response

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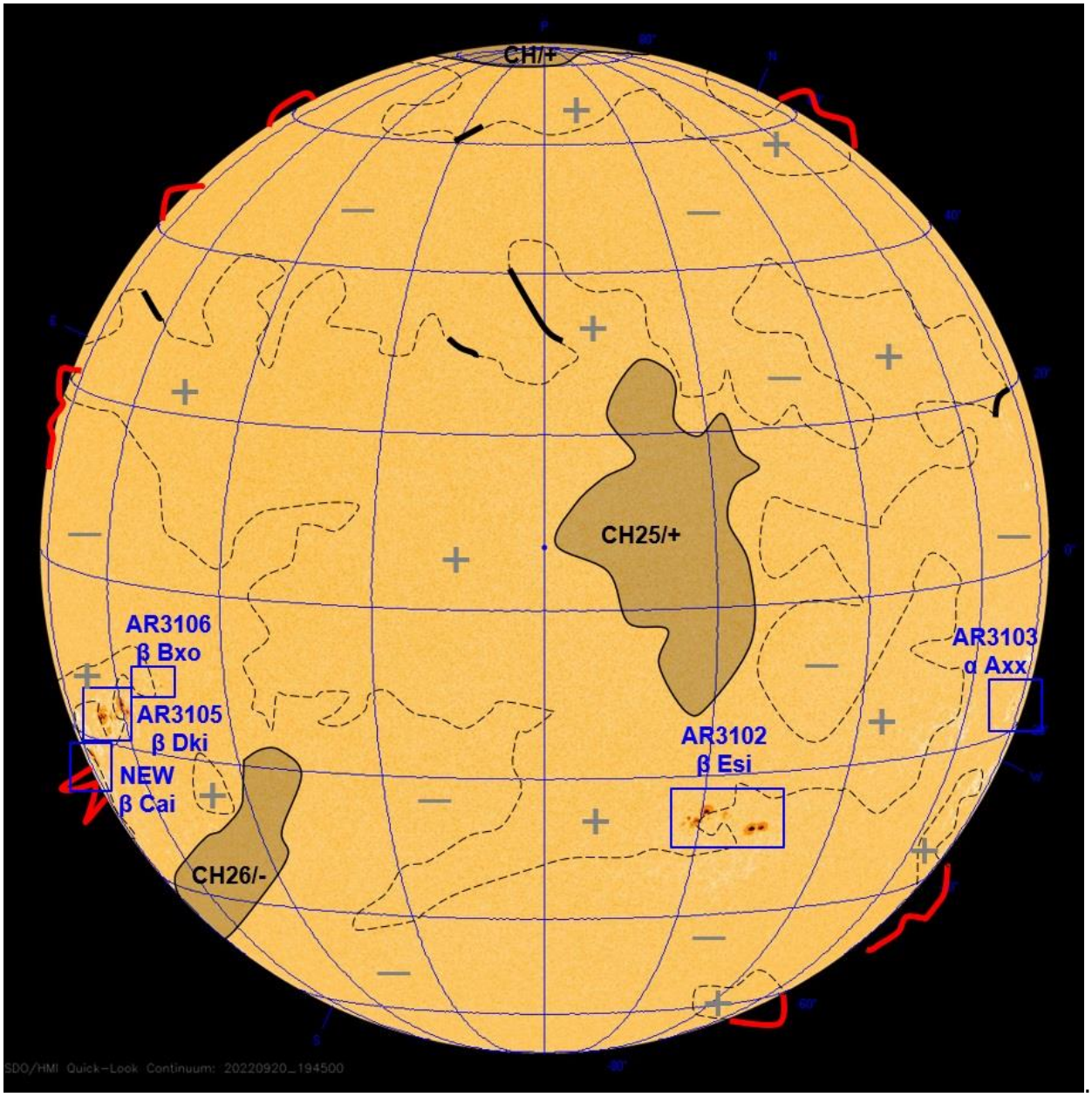
to fast wind arrival from CH25/+. This likely rising to High levels on day 4 (24th) The associated 24-hr fluence is expected to stay below the Active (1e8 integrated pfu) threshold for much of the period, but likely rising above by the end of day 4 (24th).

Figure 1. Solar Analysis Valid 20/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

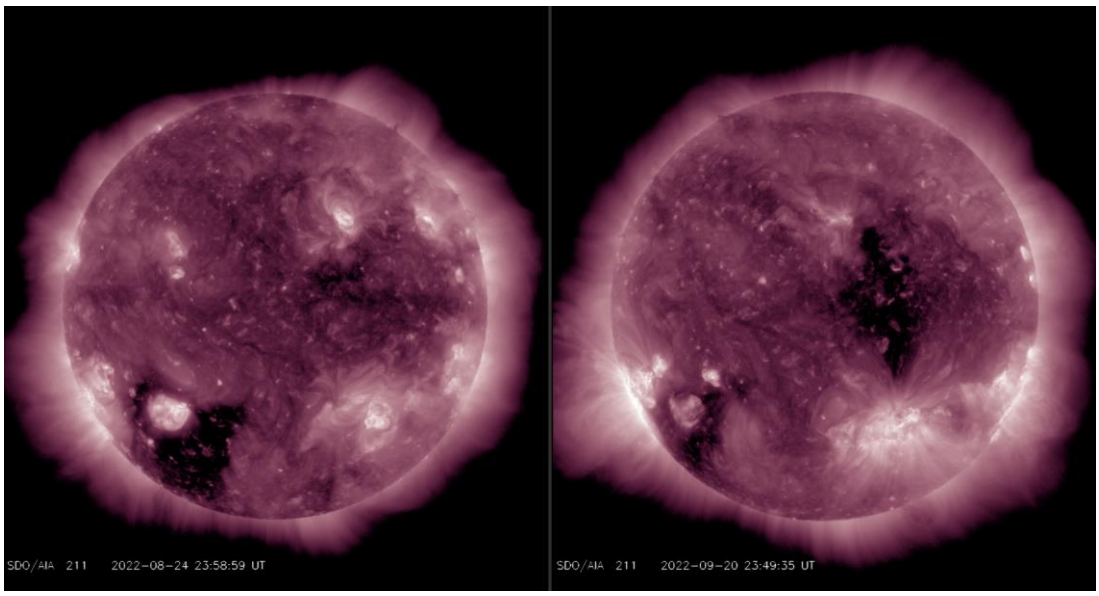
No Earth-directed CMEs have been observed.

Earth continues to exit the influence of negative polarity CH23, with the current slightly elevated solar winds likely easing to background through day 1 and 2 (21st and 22nd). There is then the potential for further strong enhancement either later on day 2 (22nd), or on day 3 (23rd) from the arrival of fast wind from CH25/+. This is uncertain however, due to this feature being much larger and more distinct than on the previous rotation, STEREO A only sampling solar wind conditions around 1.5 days ahead of Earth, and also Enlil currently suggesting a later, and weaker arrival. However, due to its positive polarity, this is favoured for connection around the spring equinox (Russel-McPherron effect), giving a chance of a notable response from any fast wind arrival or CIR region that precedes it.

Geomagnetic activity is expected to be generally Quiet with isolated Unsettled spells until later day 2. There is the potential for activity to increase to Active to G1/Minor Storms, with a chance for G2/Moderate Storm intervals either late on day 2, or day 3 (22nd or 23rd). Conditions then easing to Quiet to Unsettled, with isolated Active spells through day 4 (24th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	40	60	20
Strong	G3	No	1	5	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: SDO aia 211 of previous rotation (left) and current (right)



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Radio Blackouts - X-Ray Flares:

Solar activity is forecast to be Low to Moderate, with ongoing C-flares and a chance of further M-flares.

There are four numbered sunspot regions on the Earth-facing disc. The most active of these, has been AR3102 Esi/Beta in the southwest which has been the source of the largest flare, an M1.1 at 20/1122 UTC. This region remains moderately sized, but has seen some decay in its intermediate spots. The largest region is now AR3105 Dki/Beta in the southeast disc. More details are becoming apparent as this rotates into view, however this does appear to be in a stable configuration, aligned east to west with no notable twisting of its magnetic field. The other two regions, AR3103 Axx/alpha in the southwest and AR3106 Bxo/Beta to the northwest of AR3105, are both small and simple

A further region is becoming apparent on the southeast limb, although this has yet to be numbered. This is perhaps a small region than AR3105, but potentially in a less stable configuration, however this will need to rotate further onto the disc for a more definite analysis.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES 16/17 X-ray Flux

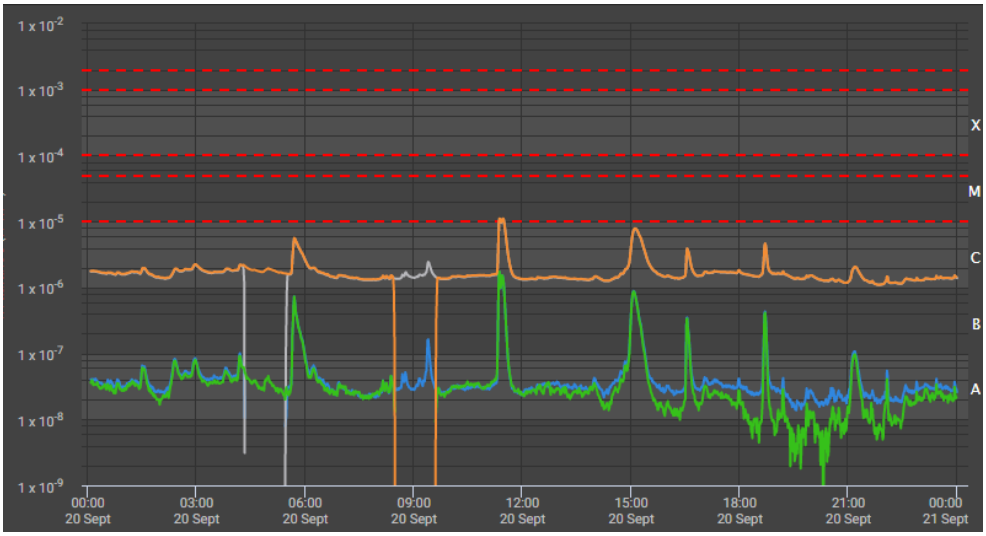

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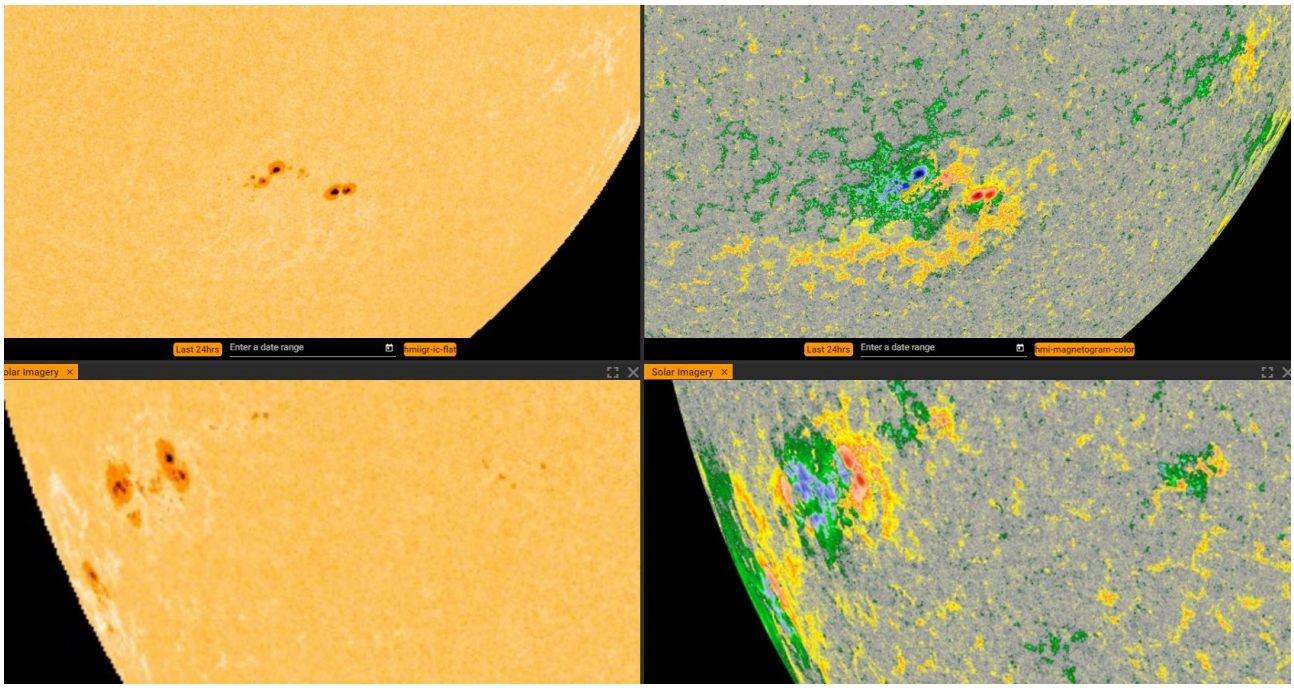
Figure 4: SDO hmi intensitygram (left) and magnetogram (right) of AR3102 (top) and SE disc (bottom)



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) observed by GOES-16 has drifted back close to background levels. The most likely source of any enhancement would be from any activity from AR3102 which is now located in the southwest quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	3	3	3	3
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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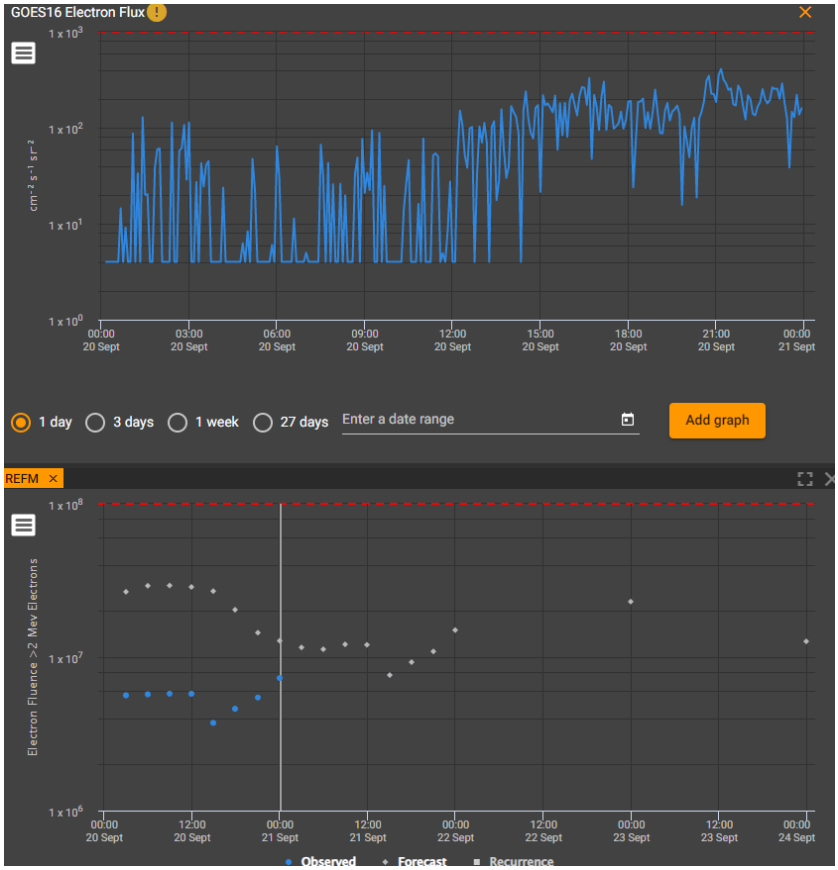
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2 MeV) as observed by GOES-16, is currently Background to Moderate with only a muted response from the recent fast wind from CH23/-. The arrival of the fast wind of CH25/- later day 2 (22nd) or day 3 (23rd) is likely to result in a stronger geomagnetic response, and subsequently High flux is likely to develop day 4 (24th).
The associated 24 hr fluence is expected to remain below the Active (greater than 1e8 integrated pfu) threshold until day 4 (24th), with REFM giving a good guide to current conditions and trends until at least day 3 (23rd). However the expected fast wind arrival is likely to be stronger than persistence suggests, limiting the models performance beyond this date.
Increasing flux later day 3 (23rd) and during day 4 (24th) is likely to bring Active fluence by the end of the period,

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	2

Figure 5: GOES 16 >2 MeV Electron Flux (top) and associated 24 hr Fluence with REFM (bottom)



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